# INVESTIGATING ASYMMETRIES IN MACROECONOMIC AGGREGATES OF CENTRAL AND EASTERN EUROPEAN ECONOMIES

**Veli Yilanci***
*Istanbul University, Beyazit, Istanbul, Turkey*

**Abstract**
This study examines the asymmetric behavior of macroeconomic aggregates for Bulgaria, Croatia and Romania by employing Triples test of Randles et al. (1980). The results reveal that while most of the macroeconomic series for Bulgaria and Croatia are characterized by asymmetric behavior; comparatively, a small number of series for Romania were found to be asymmetric. The results imply that policy-makers and researchers should be cautious when forecasting these series and making inferences using linear econometric methodologies since linear models are not capable of generating asymmetric fluctuations.

**Keywords:** asymmetry, Central and Eastern European countries, deepness, steepness

**JEL Classification:** C22

## Introduction

Examining the behavior of macroeconomic variables over the phases of business cycles has long been an important debate since the studies of Mitchell (1927) and Keynes (1936). Because there are several economic implications according to whether the variables are symmetric, which indicates the recessions and expansions are the mirror image of each other (Boldin, 1999) or asymmetric, which implies some phase of the cycle are not same from the image of the opposite phase (Sichel, 1993).

When asymmetry exists in the data generation process, then the type of the asymmetry becomes an important issue. In his paper, Sichel (1993) introduces two types of asymmetry; deepness and steepness. The former occurs when the troughs are deeper than peaks or vice versa, and the latter happens when contractions are steeper than expansions or vice versa (Belaire-Franch and Contreras, 2003).

There are two important points to emphasize. First of them is the economic reasons for asymmetries; the type of shocks at one phase of the cycle could be different from another phase (Bodman, 2001) or in the face of positive shocks, the economy may response asymmetrically as opposed to negative shocks (Beaudry and Koop, 1993). Second of them is the implications of the asymmetries; forecasting economic time series such as

* Author's contact: e-mail: yilanci@istanbul.edu.tr

unemployment or inflation rates by using linear forecast models will not give accurate results if the series are asymmetric (McQueen and Thorley, 1993) and also the results of linear unit root or cointegration tests will be spurious. Hence, both policy-makers and researchers should be aware of the possible asymmetry in the data generation process when employing economic time series.

In this study, we employ the nonparametric Triples test of Randles et al. (1980), introduced to the economics literature by Verbrugge (1997). Since the study of Verbrugge (1997), there have been several studies in the economic literature employ this test. Verbrugge (1997) investigates asymmetries in macroeconomic time series of the USA and finds that deepness is a feature of the most of the series while the steepness is a feature of employment, hours and unemployment rate. Bodman (2001) explores asymmetries in the Australian macroeconomic time series and finds evidence of steepness in consumer price index (CPI), M3 and all labour market variables, on the other hand, finds deepness only for M3. Razzak (2001) analyzes asymmetries in business cycles of six countries; Australia, Germany, Japan, New Zealand, the USA and the UK. The findings of this study show that there is a deepness asymmetry in business cycles of Australia, Japan and the UK and steepness asymmetry in business cycles of Japan and New Zealand. Narayan and Narayan (2007) test asymmetric behavior in eight macroeconomic aggregates of Singapore and find that 25% of the series are deepness and 13% of them are steepness asymmetric. Narayan and Narayan (2008) investigate asymmetries in the macroeconomic time series of three Asian economies; Hong Kong, Korea and Malaysia. They conclude that the majority of the series characterized by asymmetric behavior. Narayan (2009) examines the asymmetric behavior in health expenditures and gross domestic product (GDP) of 11 OECD countries and concludes that per capita GDP and per capita health expenditures of Finland, Iceland, Japan, Spain, the UK and the USA display asymmetry. Narayan and Popp (2009) analyze asymmetry in the industrial and residential electricity demand for the G7 countries. Only the industrial electricity demand of the UK is found to be symmetric.

The paper extends the literature by analyzing the asymmetric behavior of the macroeconomic aggregates of three Central and Eastern European countries. The rest of this paper is organized as follows. Next section provides information about the Triples test. The third section presents data and empirical results, and the final section concludes the paper.

## 1. Econometric methodology

In the Triples test of Randles et al. (1980) we consider all sample of size N and take all possible triples from the sample. If the middle observation in a triple of observations is closer to the smaller (larger) observation than it is to the larger (smaller), then the triples said to be right (left) triple; in other words, right (left) skewed.

Let

$$f\left(x_i, x_j, x_k\right) = \frac{1}{3}\left[ sign\left(x_i + x_j - 2x_k\right) + sign\left(x_i + x_k - 2x_j\right) + sign\left(x_j + x_k - 2x_i\right)\right] \quad 1 \le i; j, k \le N$$

Where ,

$$sign(\lambda)=\begin{cases}1 & if \quad x>0\\ 0 & if \quad x=0\\ -1 & if \quad x<0\end{cases}$$

So it is clear that the above function only takes values of $\left(-\frac{1}{3},0,\frac{1}{3}\right)$. The triple $\left(x_i,x_j,x_k\right)$ is a right triple if $f(x)=\frac{1}{3}$ or a left if $f(x)=-\frac{1}{3}$. This function takes the value of 0, if not skewed neither right nor left.

The Triples test examines the null hypothesis of symmetry ( $H_0:\eta=0$ ) against the alternative of asymmetry ( $H_0:\eta\neq 0$ ) using the following test statistic:

$$U=\frac{\hat{\eta}-\eta}{\sqrt{\hat{\sigma}_{\hat{\eta}}^2/N}}$$

Where $\hat{\eta}=\binom{N}{3}^{-1}\sum_{i<j<k} f\left(x_i,x_j,x_k\right)$ (such that

$\hat{\eta}=\frac{\text{Number of Right Triples-Number of Left Triples}}{3\binom{N}{3}}$ )

And

$$\frac{\hat{\sigma}_{\hat{\eta}}^2}{N}=\binom{N}{3}^{-1}\sum_{c=1}^{3}\binom{3}{c}\binom{N-3}{3-c}\hat{\varsigma}_c$$

Where

$$\hat{\varsigma}_1=\frac{1}{N}\sum_{i=1}^{N}\left(f_1^*\left(x_i\right)-\hat{\eta}\right)^2 \text{ with } f_1^*\left(x_i\right)=\frac{1}{\binom{N-1}{2}}\sum\sum_{\substack{j<k\\ i\neq j,i\neq k}} f^*\left(x_i,x_j,x_k\right).$$

$$\hat{\varsigma}_2=\frac{1}{\binom{N}{2}}\sum\sum_{j<k}\left[f_2^*\left(x_j,x_k\right)-\hat{\eta}\right]^2 \text{ with } f_2^*\left(x_i\right)=\frac{1}{N-2}\sum\sum_{\substack{i=1\\ i\neq j\neq k}} f^*\left(x_i,x_j,x_k\right).$$

$$\hat{\varsigma}_3=\frac{1}{9}-\hat{\eta}^2.$$

The test statistic is distributed $N(0,1)$, so conventional critical values can be used. This test can only be applied to stationary and trendless time series. As Bodman (2001) emphasises a time series with a trend is asymmetric by definition and since most of the time

series contain a stochastic or deterministic trend with possible breaks, we need to detrend these series employing a filter. Sichel (1993) states that; the detrending filter, which is used for analysis of asymmetry must satisfy three requirements. The filter must have a linear representation, induce stationarity and extract the appropriate component for the asymmetry test. Since Hodrick-Prescott (1997) filter satisfies all these conditions, we will use it for testing deepness asymmetry whose existence indicates that the length of the trough is deeper than the height of the peak. On the other hand, first differencing satisfies first two conditions and extracts the difference of the series which is appropriate only for steepness, so we will use it for testing steepness asymmetry whose presence implies contractions are steeper than expansions.

An advantage of this test is that it makes possible to distinguish between positive and negative asymmetry as mentioned by Razzak (2001). Positive steepness implies that the series tend to undergo rapid increases over a short period of time, on the other hand, slow gradual decreases over long period of time. Negative steepness indicates the series falls rapidly but rises slowly (Razzak, 2001). The positive deepness implies cyclical peaks are greater than the troughs, and negative deepness shows troughs are higher than the peaks (Cook, 2006).

Other advantages of the Triples test are; it is robust to outliers and changes in variances of the distribution since it is asymptotically distribution free, and the test displays good power even in small samples (Bodman, 2001).

## 2. Data and empirical results

This study uses quarterly data for three Central and Eastern European countries namely Bulgaria, Croatia and Romania. The dataset is obtained from International Financial Statistical Service of International Money Fund. Since the sample periods vary with variables used, we present the details of the sample periods in the Appendix.

The results of the Triples test for Bulgaria's macroeconomic aggregates are reported in table no. 1. These results indicate that all the macroeconomic series of Bulgaria are characterized by deepness asymmetry while all the series except lending rate are characterized by steepness asymmetry.

**Table no. 1: Deepness and Steepness Test Results for Bulgaria's macroeconomic aggregates**

| | Deepness | | | Steepness | | |
|---|---|---|---|---|---|---|
| | $\eta$ | $U$ | p-value | $\eta$ | $U$ | p-value |
| CPI | -0.0499 | -3.1243 | 0.0009* | 0.0806 | 3.4137 | 0.0003* |
| Lending rate | 0.0963 | 3.6945 | 0.0001* | 0.0246 | 0.6199 | 0.2677 |
| M3 | 0.0786 | 3.4050 | 0.0004* | 0.0637 | 2.8467 | 0.0022* |
| Nominal exchange rate | -0.0794 | -5.4425 | 0.0001* | 0.0327 | 1.6324 | 0.0513*** |
| Real GDP | -0.1005 | -2.5429 | 0.0055* | -0.0786 | -2.0474 | 0.0203** |
| Unemploment rate | 0.0913 | 2.5250 | 0.0058* | 0.0413 | 1.3784 | 0.0840*** |

Note:*,** and *** denote statistically significance at the 1, 5 and 10% significance levels respectively.

We present the Triples test results for Croatia's macroeconomic aggregates in table no. 2. The results show the bulk of the series characterized by deepness asymmetry while only three of eight series are found to be steepness asymmetric.

**Table no. 2: Deepness and Steepness Test Results for Croatia's macroeconomic aggregates**

| | Deepness | | | Steepness | | |
|---|---|---|---|---|---|---|
| | $\eta$ | $U$ | p-value | $\eta$ | $U$ | p-value |
| CPI | -0.0721 | -3.6293 | 0.0002* | 0.089 | 3.8725 | 0.0001* |
| GDP Volume | -0.1006 | -3.0606 | 0.0011* | 0.0158 | 0.4782 | 0.3163 |
| Lending rate | 0.1019 | 3.8397 | 0.0001* | 0.0113 | 0.2905 | 0.3857 |
| Nominal exchange rate | -0.0527 | -2.1635 | 0.0153** | 0.0604 | 2.5080 | 0.0061* |
| Real exports | 0.0193 | 0.4323 | 0.3328 | -0.0312 | -1.2576 | 0.1043 |
| Real government consumption | -0.1061 | -3.9670 | 0.0001* | 0.0058 | 0.2213 | 0.4124 |
| Total employment | 0.0882 | 2.7762 | 0.0028* | 0.035 | 1.3438 | 0.0895*** |

Note:*,** and *** denote statistically significance at the 1, 5 and 10% significance levels respectively.

Table no. 3 presents the results obtained from the Triples test for macroeconomic aggregates of Romania. We test eight variables and find that only nominal exchange rate shows both deepness and steepness type asymmetry while only total employment characterized by deepness asymmetry.

**Table no. 3: Deepness and Steepness Test Results for Romania's macroeconomic aggregates**

| | Deepness | | | Steepness | | |
|---|---|---|---|---|---|---|
| | $\eta$ | $U$ | p-value | $\eta$ | $U$ | p-value |
| CPI | 0.0389 | 1.2754 | 0.1011 | 0.0225 | 0.9551 | 0.1698 |
| Lending rate | 0.0408 | 1.2174 | 0.1117 | -0.0227 | -0.6332 | 0.2633 |
| Nominal exchange rate | 0.0676 | 2.0011 | 0.0227* | 0.0610 | 2.7230 | 0.0033* |
| Real exports | 0.0630 | 2.1309 | 0.0166 | -0.0408 | -1.2519 | 0.1053 |
| Real GDP | -0.0272 | -0.7274 | 0.2335 | -0.0216 | -0.6354 | 0.2626 |
| Real Government consumption | -0.0340 | -1.1556 | 0.1239 | -0.0353 | -1.1208 | 0.1312 |
| Total Employment | 0.1528 | 9.0291 | 0.0001* | -0.0412 | -1.0482 | 0.1473 |
| Unemployment rate | 0.0091 | 0.4600 | 0.3228 | 0.0270 | 1.0665 | 0.1431 |

Note:* denotes statistically significance at the 1% significance level.

In sum, all macroeconomic aggregates of Bulgaria are found to be deepness asymmetric while 83.3% of them are found to be steepness asymmetric. On the other hand, 85.7% of Croatia's and 25% of Romania's series display deepness asymmetry and % 42.8 of the series of Croatia and 12.5% of the series of Romania are characterized by steepness asymmetry. We interpret these results as follows; positive deepness in lending rate, M3 and unemployment rate series of Bulgaria; lending rate and total employment series of Croatia and nominal exchange rate and total employment series of Romania implies that peaks are greater than troughs in these series. CPI, nominal exchange rate and real GDP of Bulgaria; CPI, nominal exchange rate, GDP volume, real government consumption of Croatia are characterized by the negative deepness which indicates cyclical troughs are greater than peaks. The positive steepness in M3, nominal exchange rates, unemployment rates of Bulgaria; CPI, nominal exchange rates, total employment rates of Croatia and nominal exchange rates of Romania shows that these series rise rapidly but fall gradually. We find only real GDP of Bulgaria as characterized by negative steepness, which indicates while the real GDP rise slowly, it falls rapidly.

**Conclusion**

This paper examines the deepness and steepness type asymmetric behavior in the macroeconomic aggregates of three Central and Eastern European countries; namely, Bulgaria, Croatia and Romania by using a powerful nonparametric test of Randles et al. (1980) which was introduced into the economics literature by Verbrugge (1997). We use this test since it is robust to outliers and distinguishes positive and negative asymmetries.

The empirical results show that most of the macroeconomic variables of Bulgaria and Croatia are not characterized by symmetry. On the other hand, only a small number of Romania's macroeconomic variables are asymmetric. These findings have important implications. First, at the presence of asymmetry, the interpretations of economic fluctuations based on linear models could be inaccurate, since linear models are not capable of generating asymmetric fluctuations - as expressed by Sichel (1993). Thus, policy makers should be cautious about the asymmetries in the series when employing forecast models. Second, the existence and also the type of asymmetries provide guidance about underlying economic mechanism. For example, real GDP of Bulgaria displays negative steepness. Thanks to this finding, we can express that the fall in the GDP will be fast. Third, the researchers who test different economic theories in these countries should pay attention to asymmetry, because the results of linear econometric methods like unit root and cointegration tests could be misleading if asymmetry exists in the data generation process.

**References**

Beaudry, P. and Koop, G., 1993. Do Recessions Permanently Change Output?. *Journal of Monetary Economics*, 31(2), pp. 149-163.

Belaire-Franch, J. and Contreras, D., 2003. An Assessment of International Business Cycle Asymmetries using Clements and Krolzig's Parametric Approach. *Studies in Nonlinear Dynamics & Econometrics*, 6(4), pp. 1-9.

Bodman, P. M., 2001. Steepness and Deepness in the Australian Macroeconomy. *Applied Economics*, 33 (3), pp. 375-382.

Boldin, M.D., 1999. Should Policy Makers Worry about Asymmetries in the Business Cycle?. *Studies in Nonlinear Dynamics and Econometrics*, 3(4), pp. 203-220.

Cook, S., 2006. A Disaggregated Analysis of Asymmetrical Behaviour in the UK Housing Market. *Urban Studies*, 43(11), pp. 2067–2074.

Hodrick, R. and Prescott, E. C., 1997. Postwar Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking*, 29(1), pp. 1–16.

Keynes, J. M., 1936. *The General Theory of Employment, Interest and Money*. London: McGraw-Hill.

McQueen, G. and Thorley, S., 1993. Asymmetric Business Cycle Turning Points. *Journal of Monetary Economics*, 31(3), pp. 341-362.

Mitchell, W.C., 1927. *Business Cycles, the Problem and its Setting*. New York: National Bureau of Economic Research.

Narayan, P.K., 2009. Are Health Expenditures and GDP Characterized by Asymmetric Behaviour? Evidence from 11 OECD Countries. *Applied Economics*, 41(4), pp. 531-536.

Narayan, S. and Narayan, P.K., 2007. Understanding Asymmetries in Macroeconomic Aggregates: The Case of Singapore. *Applied Economics Letters*, 14(12), pp. 905-908.

Narayan, P.K. and Narayan, S., 2008. Examining The Asymmetric Behaviour of Macroeconomic Aggregates in Asian Economies. *Pacific Economic Review*, 13(5), pp. 567-574.

Narayan, P.K. and Popp, S., 2009. Can the Electricity Market be Characterised by Asymmetric Behaviour?. *Energy Policy*, 37(11), pp. 4364-4372.

Randles, R., Flinger, M., Policello, G. and Wolfe, D., 1980. An Asymptotically Distribution-Free Test for Symmetry versus Asymmetry. *Journal of the American Statistical Association*, 75(369), pp. 168-172.

Razzak, W.A., 2001. Business Cycle Asymmetries: International Evidence. *Review of Economic Dynamics*, 4(1), pp. 230-243.

Sichel, D., 1993. Business Cycle Asymmetry: A Deeper Look. *Economic Inquiry*, 31(2), pp.224-236.

Verbrugge, R., 1997. Investigating Cyclical Asymmetries. *Studies in Nonlinear Dynamics and Econometrics*, 2(1), pp. 15-22.

## Appendix

| Variable | Period |
|---|---|
| Bulgaria | |
| CPI | 1991Q1-2011Q1 |
| Lending rate | 1991Q1-2011Q1 |
| M3 | 1995Q1-2011Q1 |
| Nominal exchange rate | 1991Q1-2011Q1 |
| Real GDP | 2002Q1-2011Q1 |
| Unemployment rates | 2000Q1-2010Q4 |
| Croatia | |
| CPI | 1986Q1-2011Q1 |
| GDP (volume) | 1999Q1-2011Q1 |
| Lending rate | 1992Q1-2011Q1 |
| Nominal exchange rate | 1992Q1-2011Q1 |
| Real exports | 1997Q1-2011Q1 |
| Real government consumption | 1997Q1-2011Q1 |
| Total employment | 1994Q1-2011Q1 |
| Romania | |
| CPI | 1990Q4-2011Q1 |
| Lending rate | 1994Q1-2011Q1 |
| Nominal exchange rate | 1984Q1-2011Q1 |
| Real exports | 1998Q1-2010Q4 |
| Real GDP | 1999Q1-2010Q4 |
| Real government consumption | 1998Q1-2010Q4 |
| Total employment | 1996Q1-2011Q1 |
| Unemployment rates | 1993Q4-2011Q1 |